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HYDROGEN-OXYGEN REACTION STUDIES

First Quarterly Progress Report

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1.0 Introduction

This first quarterly report covers the first period of effort on the study to determine the nature and extent of the explosion and detonation hazard associated with the venting of hydrogen and oxygen propellants. Progress in assembling the apparatus and a description of the procedure is presented together with comments on results achieved.

2.0 Objective

The program is aimed at determining the parameters which define the hazard associated with the coexistence of hydrogen and oxygen in the condensed state. This condition can be achieved by leakage, by venting, or by operating conditions which allow the propellants to come together in confined or unconfined spaces. To simulate these conditions, the propellants will be brought together in the proper phase by regulating the system pressure and the ambient pressure of the propellant charge. The propellant system will be subjected to various ignition sources at several fuel-oxidant ratios. The time and pressure data of the resulting explosions and/or detonations together with photographic records will supply the experimental information from which specific answers to the problem will be deduced.

3.0 Experimental

3.1 Vacuum Chamber

The vacuum chamber in which the tests will be conducted is a 4' x 10' x 5/8" thick steel tank rated for 450 lb. pressure (see figure 1).

It is fitted with an access door and 10 portholes for viewing and instrumentation. The tank is connected to a Beach-Russ vacuum pump rated at 750 cu. ft. per minute and capable of producing a vacuum of better than 10 microns.

The eight inch line to the pump is constructed by a four inch vacuum valve for setting a coarse level of pressure. Fine control of the chamber pressure may be achieved by a vacuum bleeder valve and, if necessary, a drain valve at the rear end of the vacuum chamber.

The main chamber contains a track covered with 1/8 inch rubber. A rubber wheeled carriage rides on the track. The carriage supports a 2 1/2" pipe holding five channels of pressure instrumentation. The pressure transducers are mounted on struts bolted to the pipe support with pipe clamps and insulated from it with lead and rubber. The struts may be moved around the circumference of the pipe or along it. Five additional transducers are located at one foot intervals along the top of the tank. Their positions are fixed. The transducer outputs lead through a port to a cathode follower circuit which feeds into oscilloscopes.

Two ports at the top of the chamber hold flanges through which propellants may be fed into the chamber. The layout is shown schematically in fig. 1.

3.2 Instrumentation

The instrumentation installed in the tank consists of two types of pressure transducers. The transducers on the carriage are Atlantic Research BD-15 Blast Velocity transducers. The transducers on the tank are Convair-built with barium titanate crystal elements.

A calibration system for the transducers can be used with the transducers in place. It consists of an air supply system which can be pressurized to any predetermined level and read on anabsolute manometer or gage. A solenoid valve operated by a trigger mechanism exposes the transducer to a step-pulse pressure. The response is then recorded on the oscilloscope and gage factors calculated. These may be varied to meet the test requirements. Appropriate mating units between the transducer and the pressure nozzle provide for accurate tests to be made. Because the test apparatus isportable, checks can be made on the transducers in their operating position.

3.3 Propellant System

The hydrogen propellant system will consist of a standard hydrogen discharge tube leading to a valve on the flange at the top of tank. The hydrogen inlet in the tank is surrounded by a jacket through which gaseous hydrogen is vented and through which the bulb may be evacuated in order to prepare solid hydrogen. Nitrogen will be continuously bled through the hydrogen vent line. The oxygen system contains a direct line from the LOX container to the valve at the top of the test chamber. The remainder of the system will be the same as the hydrogen system. It is shown in figure 2.

4.0 Procedure

The procedure will follow essentially our preliminary experiments which are as follows: Evacuate the test chamber until pressure gage reads zero. Then pressurize the LOX tank until the LOX bulb is filled with liquid oxygen. Now evacuate the LOX system until solid forms in the bulb. At this point carefully bleed oxygen into the system, then increase the pressure until the solid just melts. Note the quantity of oxygen present in the standard sized bulb.

Re-evacuate to refreeze the oxygen. Make corrections as per test for loss by sublimation and vaporization.

The described procedure will give a known quanity of solid oxygen expected to be close enough for our calculations. The quantities of liquid may be read from calibrated glass tubes.

Solid hydrogen has not yet been made pending completion of the system and vent piping. It is expected that solid hydrogen will be prepared but that the quantitative manipulations will require more delicate control than with oxygen.

5.0 Results

Results to date show that the test chamber is excellent for accomplishing the work. The chamber can be evacuated to the limit of the pressure gage attached. This gage would show a pressure of 0.2 mm easily.

The pressure transducers respond at the level expected expected from the explosions. However, the Blast Velocity transducers exhibit 0.15 psia ringing amplitude so they are being better insulated from the chamber by rubber.

The control of the phases can be readily accomplished for LN_2 (or LOX). The quantity and the phase of LOX may be readily controlled. It is expected that hydrogen will be more difficult to control but it will likewise be tractable when more care is used.

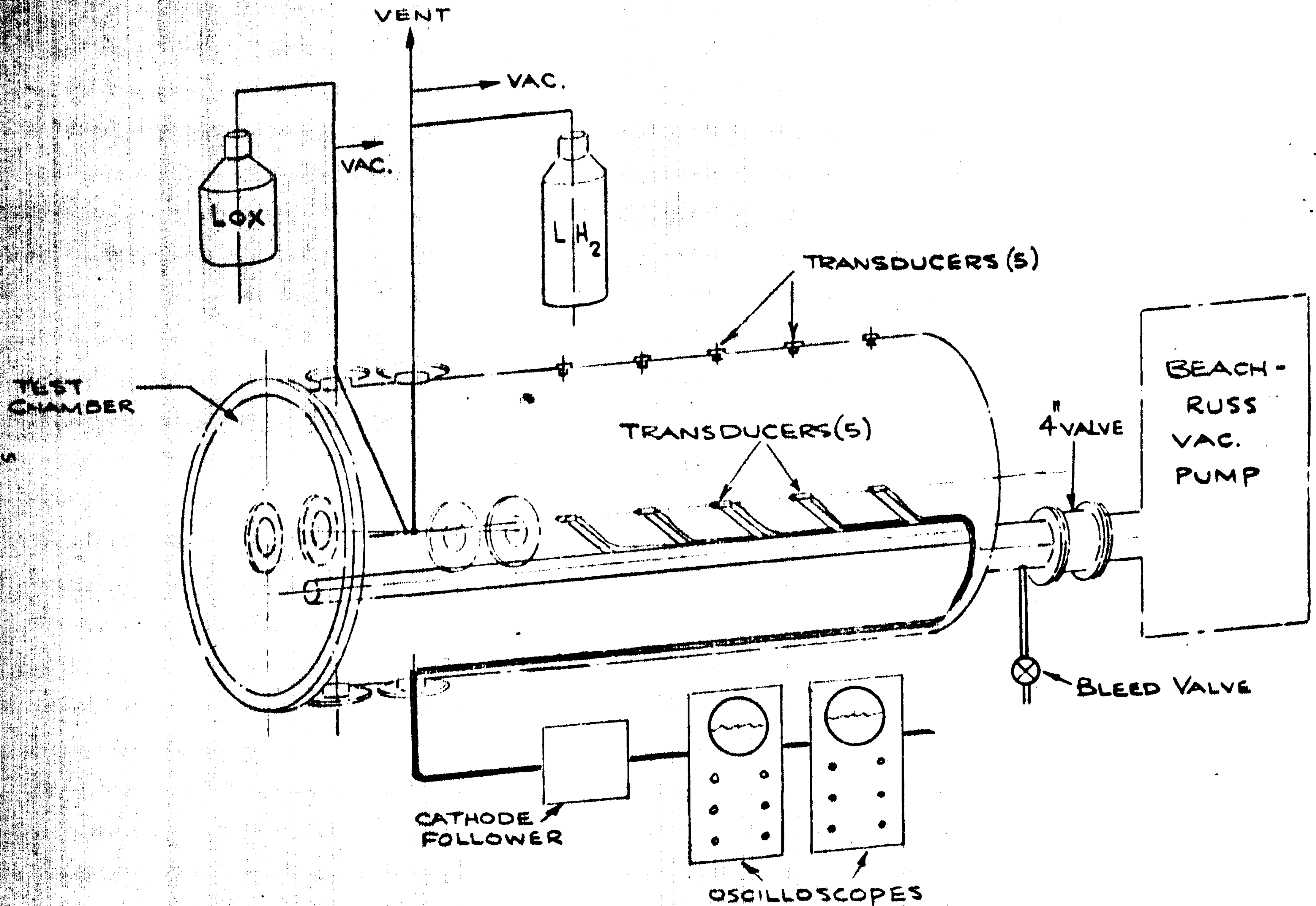

FIG. 1: APPARATUS FOR HYDROGEN-OXYGEN STUDIES

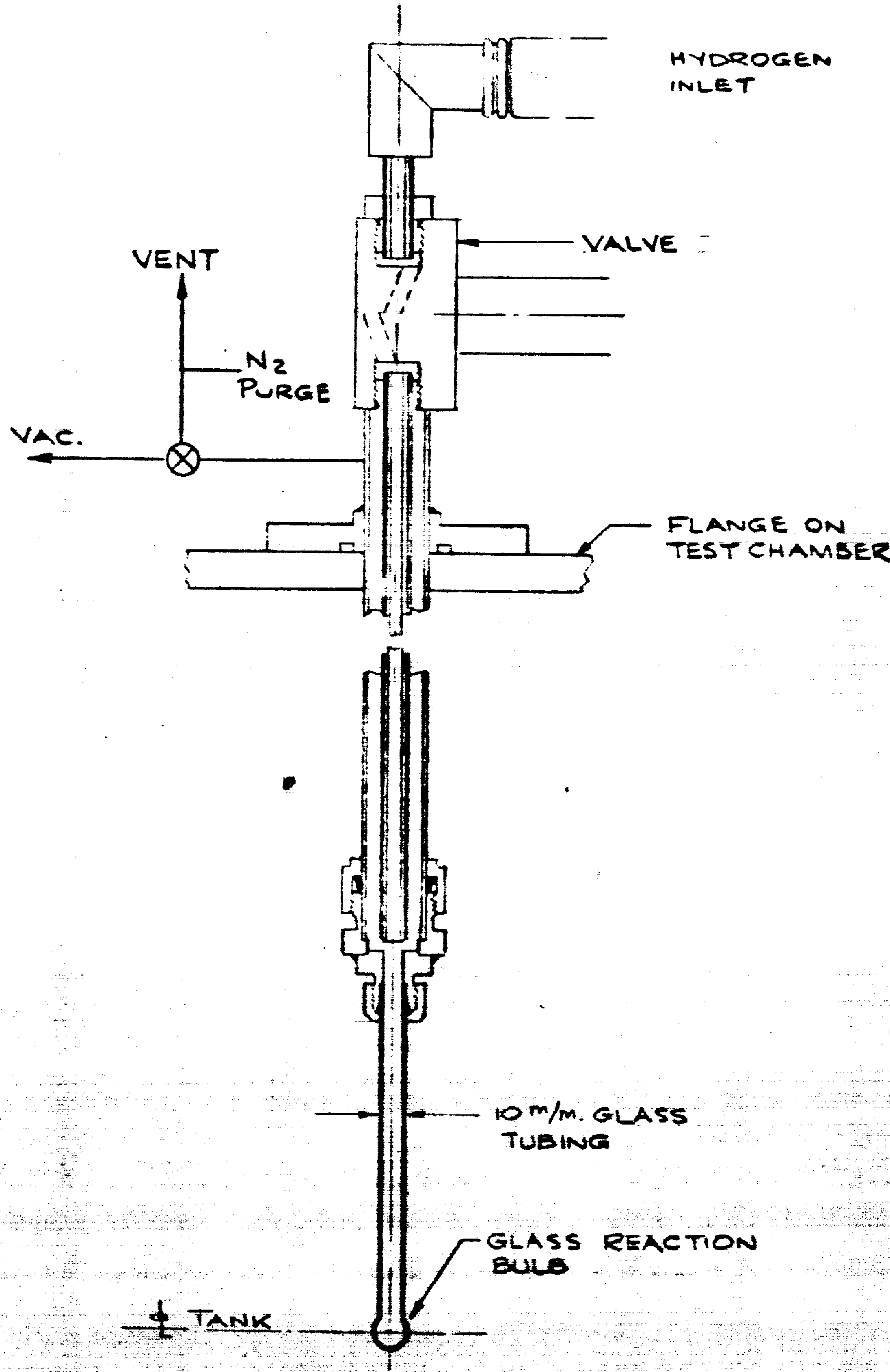

FIG. 2: SKETCH OF H_2 HANDLING SYSTEM